
Reliability of Posterior Tibial Slope Measurement on Magnetic Resonance Imaging versus Computed Tomography

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Studied performed at University of California Irvine

Disclosures

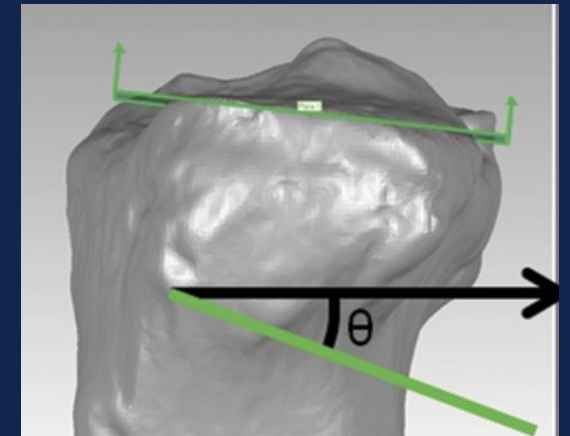
Wang:

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Wen, Bohlen: None

Introduction

- **Posterior tibial slope (PTS) reflects the relative tilt of the tibial plateau¹**
 - Measured as the angle between the perpendicular to the long axis of the tibia and the tangent to the tibial slope
 - $PTS \geq 12^\circ$ is associated with increased rates of anterior cruciate ligament (ACL) injury and ACL graft failure²⁻⁴
- **Recent investigations have delineated distinct roles of the medial tibial plateau (MTP) and lateral tibial plateau (LTP) geometries on anteroposterior and rotatory stability of the knee⁵⁻⁷**
 - Individual measurements of MTP and LTP slope may help to guide treatment of ACL injuries



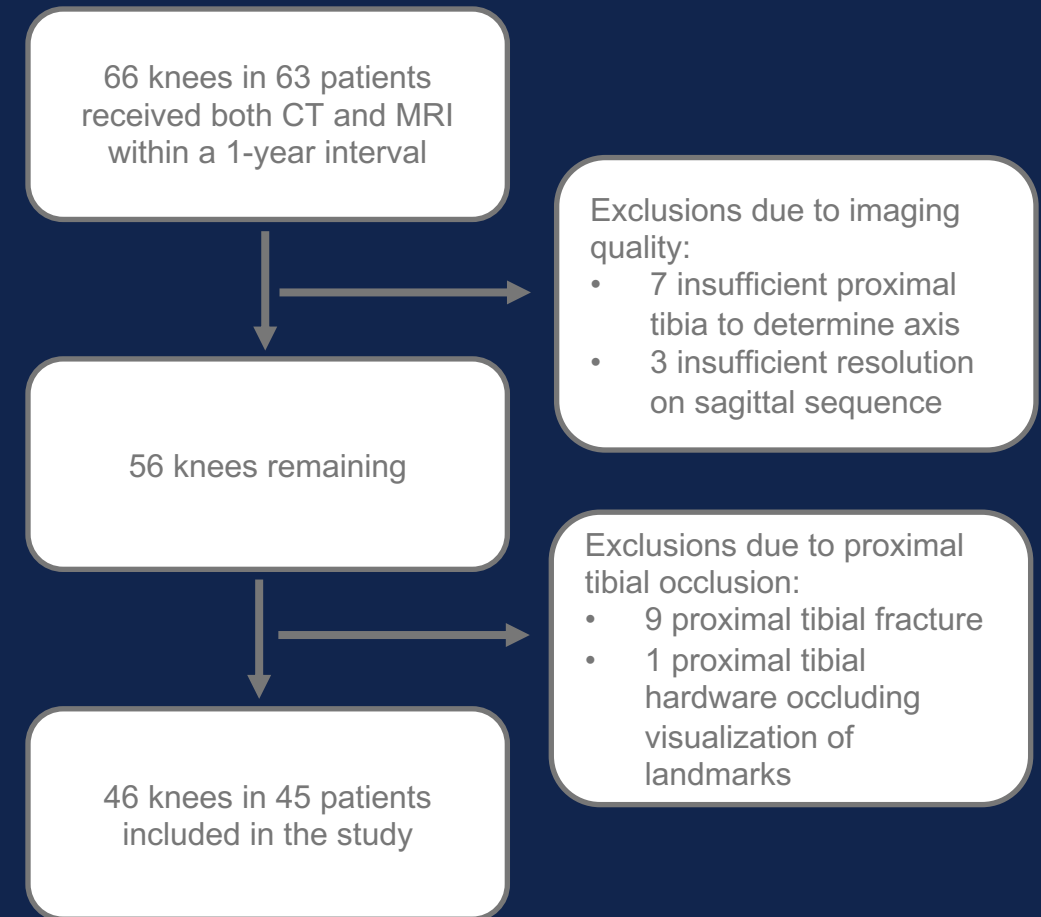
Introduction

- **Diagnostic workup of patients with ACL injury typically includes magnetic resonance imaging (MRI) but not computed tomography (CT)**
 - CT is the gold standard for evaluating the osseous geometry
- **It is currently unknown whether traditional MRI can be used to accurately measure PTS of the MTP and LTP and how MRI measurements correlate to those on CT**

The purpose of this study was to compare PTS measurements of the MTP and LTP on MRI versus CT

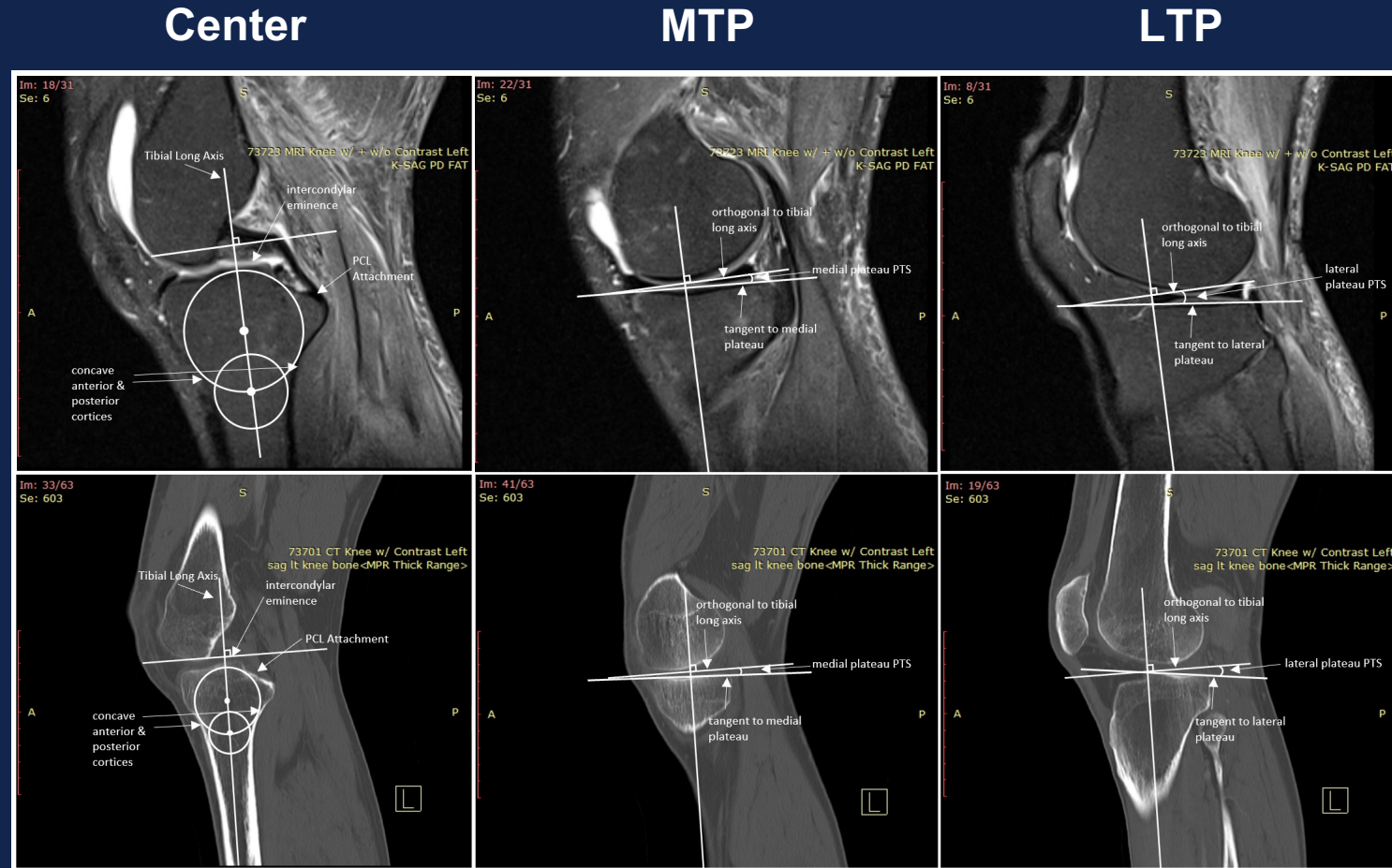
Methods: Patient Selection

- After IRB approval, an institutional picture archiving and communication system (PACS) imaging database was retrospectively queried to identify patients who had concurrent MRI and CT imaging of the same knee within a one-year interval
- Patients aged 15 to 63 years were included in the study
- Exclusion criteria: knees with significant deformity, proximal tibia fracture, or artifact that obscured visualization of proximal tibia landmarks



Methods: PTS Measurement

- PTS of the MTP and LTP were measured by two independent raters on paired MRI and CT studies
 - Measurements were performed according to a previously described validated method by Hudek et al.⁷
- Interrater reliability of PTS measurements assessed using the intraclass correlation coefficient (ICC)
- Intermethod agreement between MRI and CT measurements assessed using the ICC and Bland-Altman analysis



Results

- Interrater reliability for PTS of the MTP and LTP ranged from 0.64-0.83 (Table 1)
- Intermethod agreement between MRI and CT of MTP was poor (ICC = 0.34-0.42)
- Intermethod agreement between MRI and CT of LTP was moderate (ICC = 0.59-0.70)
 - PTS measurements for MTP and LTP were lower on MRI compared to CT as measured by Rater 2 (differences of 0.95° [p = 0.05] and 0.99° [p = 0.03], respectively, on paired t-test)

		ICC	95% LOA	
			LB	UB
Interrater medial	MRI	0.78	-3.11	3.80
	CT	0.80	-4.29	2.78
Interrater lateral	MRI	0.83	-4.37	3.43
	CT	0.64	-7.02	3.51
Intrarater medial (Rater 1*)	MRI	0.85	-3.13	2.56
	CT	0.88	-2.99	3.16
Intrarater lateral (Rater 1*)	MRI	0.89	-2.87	3.32
	CT	0.87	-3.47	3.35

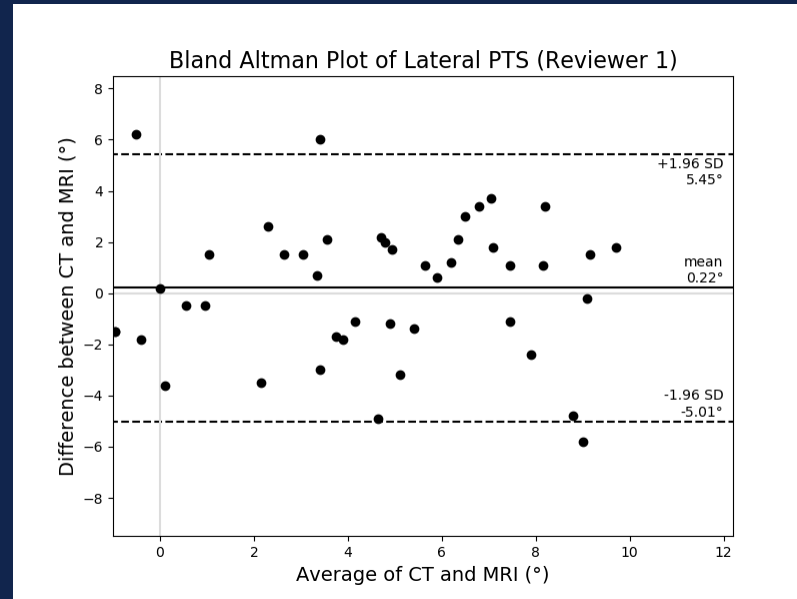
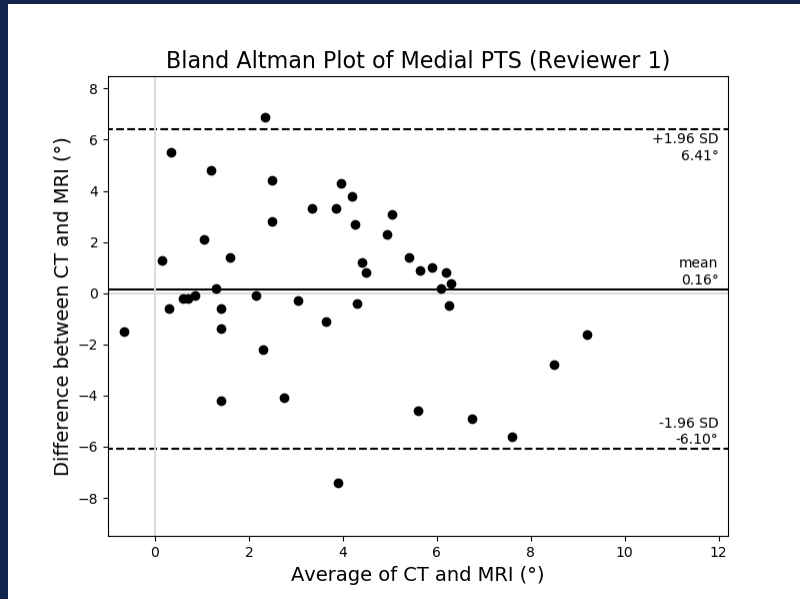
Table 1. Interrater and intrarater reliability.

		ICC	95% LOA		p (two-tailed t-test)
			LB	UB	
Intermethod (Rater 1*)	Medial	0.42	-6.10	6.41	0.74
	Lateral	0.70	-5.01	5.45	0.58
Intermethod (Rater 2*)	Medial	0.34	-7.22	5.33	0.05
	Lateral	0.59	-6.84	4.85	0.03

Table 2. Intermethod agreement.

*Rater 1 is the 2nd year medical student. Rater 2 is the orthopedic surgery resident. ICC, intraclass correlation coefficient; LOA, limit of agreement as calculated by Bland-Altman analysis; LB, lower bound; UB, upper bound

Results



Posterior tibial slope averages and mean absolute value difference between CT and MRI

	Mean	Min	Max
MTP MRI	$3.5^\circ \pm 2.6^\circ$	-4.7	8.4
MTP CT	$3.6^\circ \pm 3.2^\circ$	-3.8	10.4
MTP MRI - CT	$2.5^\circ \pm 2.0^\circ$	0.0	9.0
LTP MRI	$4.7^\circ \pm 3.4^\circ$	-2.9	10.6
LTP CT	$4.9^\circ \pm 3.6^\circ$	-3.6	-15.7
LTP MRI - CT	$2.3^\circ \pm 1.7^\circ$	0.0	7.7

Bland-Altman plots demonstrated high variability and minimal bias of PTS measurements on MRI compared to CT

Discussion

- **PTS can be a helpful measurement when treating patients with ACL pathology**
 - Predict risk for post-reconstruction failure
 - Guide decisions on performing concurrent osteotomy^{1,5,9,14}
- **Accurate and consistent measurements of PTS are needed for it to be a useful clinical tool**
 - Small differences in PTS can have clinically different outcomes: differences even as small as 0.7° may associated with clinically significant effects on ACL grafts¹³⁻¹⁴
- **There is no standardized method to measure PTS of the individual plateaus**
 - The Hudek method (used in this study) has generally been the most widely used^{7,14}

Discussion

- **The method used in this study for measuring PTS of the individual plateaus demonstrated high interrater and intrarater reliability**
- **The results of this study demonstrated poor-to-moderate agreement and high variability in PTS measurement of the MTP and LTP between imaging methods**
 - Poor-to-moderate agreement according to ICC analysis⁸ and high variability with minimal bias according to Bland-Altman analysis
 - CT and MRI measurements of PTS of either the MTP and LTP may not be interchangeable
- **The results are consistent with other studies showing variable agreement between CT and MRI measurement of bony landmarks of the knee**
 - TT-TG was shown to be different^{6,9}
 - MTE was shown to be the same¹⁰
 - ACL bone tunnel size was shown to be comparable in some planes but not others¹¹⁻¹²

Conclusions

- **Poor-to-moderate agreement was observed for measurement of PTS on CT versus MRI**
 - High variability and minimal bias seen between measurements of PTS of the MTP and LTP on paired MRI and CT studies
- **Measurements of medial and lateral PTS may not be reliable on traditional MRI**
 - CT may be required clinically to accurately quantify the individual slopes of the MTP and LTP

Thank You



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